List of Abstracts for National Workshop

at

IIT Guwahati, (Assam)

1. Variation of a few Bio-Chemics in Drought Tolerant and Susceptible Clones in Tea [Camellia sinensis (L.)O.Kuntze.]

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Abstract

Organic compounds like abscisic acid (ABA), proline and epicuticular wax are known to have some important attributes for drought tolerance in plants. Tea clones representing both tolerant and susceptible categories were selected for estimation of the above mentioned parameters with an objectives to assess their concentration under non stress situation.

The ABA level of drought tolerant clones were about ten fold higher than those of susceptible clones. The mean ABA content of mature leaves in drought tolerant clones were 0.842 µg g-1 against only 0.07 µg g-1 in susceptible clones. Proline – a drought signaling amino acid was significantly higher ($P < 0.001$) in tolerant (4.08 µ mol g-1 fr.wt.) as compared to susceptible category (2.45 µ mol g-1 fr.wt.) of clones. Among the tolerant clones MB-107, a TRA/Garden series clone contained highest concentration of proline (5.18 µ mol g-1). A highly significant correlation ($r = 0.88^{***}$) in proline content between drought tolerant and susceptible clones was observed. Epicuticular wax content of tolerant groups (60.97 µg cm-2) was higher than the susceptible group (57.10 µg cm-2)

These findings can be utilized in determining the possible response of a clone to drought before it is released to the industry for commercial use.

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2. Exotic Eucalyptus Plantation in the Brahmaputra Valley: A study on Ecological Impact on soil thereof.

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Abstract:-

Soil and vegetation have a complex interrelationship one influencing the other. Thus the influences of plantation on soil are to be taken as determining factors in choice of species for tree crop combination or for tree plantation. This is for the fact that soils support particular type of flora and fauna and hence a particular characteristic climate. Soil environment is quantitative terms by the type of vegetation growing on the soil including the rate of growth, rate of return of litter and the size and the longevity of the root system under available climate regime. It is to be noted that differences in vegetation type is likely to impart differences in soil properties. This investigation covers a study on various physico-chemical aspects of soil properties covered by exotic Eucalyptus Citriodora plantation(EEP), Indigenous Gamari (Gmelina arborea Roxb) plantation(IGP) and soil of barren or uncovered condition (treated as control).

Physical properties of soil exhibited the variation in percentage of sand, silt and clay under various plantations. The percentage of sand was highest in soil under EEP site while percentage of clay minerals was found to be highest in IGP site followed by barren site. On the other hand, moisture, organic carbon, total nitrogen and phosphorous contents in soil under IGP site were found to be highest while highest C:N ratio and lowest pH were found under EEP site. Potassium content was highest under the soils of EEP site as compared to that of soil under IGP and Barren sites. Exchangeable potassium in soil was higher under EEP site, whereas exchangeable Ca, Mg and Na and percentage of base saturation were comparatively higher under IGP soil with almost equal cation exchange capacity (CEC) in all sites of study. X-Ray analysis of soil samples showed that soil covered by EEP contained a-quartz as the major and rutile as minor phase and in a very few samples plagioclase was traced. While soil covered by IGP contained a-quartz as the major phase and rutile, muscovite, plagioclase, montmorrillonite and chlorite as minor phase followed by uncovered or barren soil. Thus it can be concluded that this man-made forest of EEP has

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an affect of change in soil contents and hence nutrient distribution as well as mineral availability in soil.

3. Potential of naturally occurring entomopathogenic fungi and their prospects in biological control of insect pests of tea, *Camellia sinensis* (L). O Kuntze in North East India

Debnath S, Barthakur B Kand Dutta P

Abstract

Economic impact of insect pests attack on crop production and general health of cultivated tea plants, *Camellia sinensis* in North East India is well documented. Insect pests are essentially controlled by application of pesticides by adopting principles of integrated pests managements. Risks of pesticide residue build up in made tea, pest resistance to pesticides, pest resurgence are increasingly become complex. Biological approach for control of pests as components of integrated pest managements in developing countries is recognized as viable alternative to reduce pesticide use. Native entomopathogenic fungi are currently being considered all over the world as pest control agents and success have been claimed in many developed countries. Tea ecosystem in North East India harbour a rich diversity of entomopathogenic fungi (*Verticillium laccani, Paecilomyces tenuipes, Fusarium coccophilum, Acrimonium* spp., *Paecilomyces lilacinus, Metarhizium anisopliae, Aschersonia* spp., *Fusarium* etc.). Pesticide application in tea ecosystem poses considerable risk to the survival of entomopathogenic fungi. This paper examines the extent of occurrence, problems of mass production, formulation, field application technology and regulatory issues for utilizing entomopathogenic fungi as pest control agents with particular reference to tea ecosystem in North East India.

4. Imbalances in the System of S&T of North-Eastern States: An Assessment

Dinesh Abrol and Pulamte.L[*1]

Abstract:-

This paper views the design of public policy and strategy of integration of S&T with regional development needs in the Indian North-eastern (NE) states as a problem of overcoming the

vicious cycle of underdevelopment set long ago in the region. The cycle is considered to be vicious because successive development interventions have ended up reproducing so far dualisms in the structures of production and imbalances and fragmentation in the system of technological infrastructure. Policies formulated for the regional governance of integration of S&T with development needs have been unable to put in place a virtuous cycle of development in the region. In the region the system of production and innovation is failing to grow over time by itself in a sustainable manner.

Our analysis indicates that explanation for this lies within the tendency of the existing driving forces in both business and S&T to persist with the practice of myopic systems of innovation, promotion of linear models based technological infrastructures, choice of inappropriate designs of technology systems and encouragement to enclaves creating patterns of natural resource based economic development. Alternate designs of technological systems and blocks of competencies that would allow sustainable development blocks are lacking. For whose creation the local producers of products of down stream industries, traditional crafts, agriculture and forestry and artisan industries will have to also get an effective access to and influence over the development of regional technological infrastructure, finance and industrial policy formulation. The lack of mobilisation of these forces is identified as a key failure of the regional governance of integration of S&T with development. Strategies being deployed currently for the development in the direction of improving their influence through the proactive anticipatory interventions for development of the region are touched in brief for the benefit of drawing appropriate lessons from the recent experiences of experiments going on in the region.

The paper is divided into five distinct sections. Section 1 outlines in brief the relevance of the discourse going on in the developed countries over the emerging patterns of regionalisation of innovation for an evaluation of the policies of Indian NE states that are making the region incessantly peripheral. Section 2 discusses the political economy of the design of the regional governance of development of production and sector specific in-house technological infrastructure. Section 3 details the patterns of evolution of regional imbalances in the system of publicly funded technological infrastructure developed for the seven North-eastern states. Section 4 connects the evolving patterns of imbalances and mismatches in the innovation intensive environments with the historically constituted processes of political economy at the tate and central government levels. Section 5 reflects

in brief on the processes of formulation of the policy for regional planning of integration of S&T with development needs in the context of the ongoing discourse on triple helix. It recommends the introduction of a new package of innovation policy instruments to promote a new pattern of collaboration for innovation in the Indian North-eastern states.

5. REST assured, India can shine

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Abstracts:-

Germany, in 1994, created a super ministry called the Zukunftsministerium - Ministry of the Future. It had four departments, and they were: Research, Education, Science and Technology (REST). REST stood for the pillars on which any modern economy rests. For India to be a Global Leader in 2020, we must look at where we are now, and project what we have to do in these 4 areas. This talk will examine this aspect critically.

6. Weather forecasting and Regional Development
The Case for the North-east

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Abstracts:-

Advance and reliable weather forecasting can play a significant role in the development of a region in a sustainable and eco-compatible way. This is particularly true for regional economies based on agriculture and natural resources, such as those of NE

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India. In the short-term, reliable weather forecasts can help to optimize crop choice, sowing schedule, harvest planning as well as irrigation and fertilizer schedules. In the long-term, such forecasts, through impact assessment, can help to certain as sustainability and eco-compatibility of activities like forest harvesting and agro-expansion

In the last few decades, the science of weather forecasting has evolved into arigorous, quantitative discipline. Propelled by a global research effort and enabledby high-speed computing, the operational forecasting centres in many parts of the world now record impressive skill, at least in short range (a few days) forecasts. However, this benefit of modern science and technology is yet to be fully realized in India, especially at a regional scale.

There are two major reasons for low utilization of weather forecasting technology in India, and more specifically over NE India. The main driver of a forecast engine, the dynamical forecast model, passes through several layers of approximations, from (a set of universal) continuum equations, to arrive at a computer code. The discretized nature of numerical solution makes it necessary to make a number of assumptions which are often specific to scale, process and region (such as the tropics vs the mid-latitudes). This results in significant geographical variations in this performance of the model. It is therefore often necessary to modify, calibrate and redesign a model for specific applications. This is particularly true for India which has great climatic diversity and especially for the NE which is characterized by unique bio-geospheric properties.

It is therefore necessary to initiate a regional weather information service. This could be modelled as a platform of collaboration between state governments, research organizations and operational agencies like IMD to arrive at an optimum blend of research, development and application.

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7. Utilization of Wild Banana Plants for Paper, Pulp & Cordage Industries

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Abstracts:-

Possibilities of wild banana plants for making pulp, paper and cordage fibres were studied. Two species of wild banana plants such as *Musa nagensium, Prain* and *Musa flaviflora* were collected from hilly areas of Assam and Nagaland. The morphological characteristics of the plants such as stem length 3.5 and 3.7 metre, stem diameter 25 and 28 cm, number of sheaths per plant 10 and 15, biomass per plant 1.5 and 2 kg were recorded respectively for both the plants. The anatomical properties of the plants/fibre were determined and the average fibre length recorded as 1.20 and 1.35 mm, and width 20.2 and 18.8 μm while fibre cell wall thickness recorded 5.8 and 6.2 μm. For extraction of fibres, the sheath materials were crushed in a two roll crusher and then digested with 8% sodium hydroxide at bath ratio 1:8 for 3 hours at boiling temperature under pressure free condition. H-E-H sequence was used to get pulp of 75% brightness. The unbleached and bleached pulp yield recorded 44.8 and 40.7% respectively for both the species. The Kappa numbers recorded were 25 and 27and brightness of bleached pulp obtained were 73 and 75% for both the species. Paper samples (60 gsm) were made in the laboratory hand sheet former and the physical strength properties of the paper sheets were determined. Tensile index 57.5 and 55.3 Nmg^{-1}, burst index 4.5 and 4.2 $Kpam^2g^{-1,}$ tear index 9.32 and 8.61 mNm^2g^{-1} and folding endurance 250 and 280 recorded for *M. nagensium* and *M. flaviflora* respectively.

For extraction of fibres useful for cordages, the sheath materials were digested under pressure free condition as above using 10% Na_2CO_3 for 3 hrs at boiling temperature. The yield of the fibres recorded 53% and 55% respectively for both the plants. . Two and three ply twines were made from such plants and the breaking load of the fibres were recorded as 170.3 N and 170 N. From the above study it has been observed that the above two species of banana plants would be a potential source for cordage and paper industry.

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8. Biopesticide Technology and Entrepreneurship Development

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Jorhat-785 013

Abstracts:-

In India, decline of annual pesticide consumption from 61,260 million tones in 1995-96 to 46,195 million tones in 1999-2000 is accompanied by concomitant increase in the growth of the biopesticides industry. The pesticide consumption scenario in the North East follows a similar trend having a great potential for biopesticide industry to grow as well as for organic food production. In this region, tea and vegetables are the crops in which maximum use of pesticides takes place at a tune of 8.20 to 16.94 kg or l/ha/annum. This practice leaves undesirable residues in the finished products making them unacceptable in the export market, and they also become health hazardous to the domestic consumers. This is quite alarming. To overcome this dismal situation, biopesticides like microbials, parasitoids, predators and botanicals may play a major role, and create opportunities for developing industries worth Rs. 540 million. Development, formulation and popularization of these agents have already begun at various R&D institutes in this region paving the way for the small and large entrepreneurs to capture the huge market in the tea and other agri-horticultural sectors.

At Assam Agricultural University, Jorhat thrust has been given to mass produce *Beauveria bassiana* (Bals.) Vuill. for the control of the rice hispa, *Dicladispa armigera* (Olivin) (Coleoptera: Chrysomelidae) and the tea mosquito bug, *Helopeltis theivora* Waterhouse (Hemiptera: Miridae), two most devastating pests of rice and tea, respectively. The former one causes 35-100 % loss in yield, whereas the latter causes 65 % loss. The medium for its production is consisted of rice husk, saw dust and rice bran (RH: SD: RB medium) yielding $38X10^7$ spores/ml having potentiality of 78 - 87%. This strain is highly pathogenic with LC_{50} value of 90.16 spores/ml. Since *D. armigera* adults are gregarious, they disseminate fungal spores quickly from one individual to another producing epizootic condition in the

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population. White frosty mycelial growth covers the entire body surfaces and hyphae emerged through the intersegmental sutures of the body.
Field performance of this agent is very encouraging not only in terms of the pest suppression but also in increasing yield, thereby fetching higher economic returns to the farmers compared to the conventional insecticides.

In addition to this, efforts are also made to demonstrate the feasibility of the use of parasitoids, *Trichogramma* sp. against the lepidopteran pests of rice, tea and vegetables. Similarly, NPV has been produced and tested against the pests of tea and vegetables, which shows great promise. Similar works are in progress at different institutes of the North east. Furthermore, for the management of the soil borne pathogens in tea and vegetables, bioformulations prepared out of *Trichderma* sp., *Pseudomonas* sp., etc. have become very popular among the farmers. Bioremediation through the use of microflora fro the gut of insects has also been initiated in these institutes

Amongst the botanicals, besides neem formulation, works are in progress on identification of newer plants as North East is endowed with rich diverse floral composition having pesticidal properties. Promising ones are *Aegle marmelos*, *Phlogocanthus thyrisiflorus*, and *Clerodendron inerme*, etc., in this direction this University has made substantial progress in collaboration with RRL, Jorhat. Training for the development of entrepreneurs in the North East is of prime importance followed by collaborative R&D activities amongst the leading institutes of the region like Assam Agricultural University, Tezpur University, Regional Research Laboratory, Gauhati University, etc. Human Resource Development must also be geared up to sustain the growth of this industry in the region by opening vocational courses at college and university level, introduction of courses on this topic in the Under Graduate and Post Graduate degree programmes. Biopesticides, in the long run, will bring a revolution in this region by increasing organic food production and encourage farmers to go for IPM. In this case, another area which requires a great deal of attention is the biofertilizers; works on this direction have also been geared up in the NE.

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9. Geoenvironmental apprisal of Khasi hill district, Meghalaya in ne India and Management of its degraded Ecosystem

Kalpana Deka Kalita, Bikash Gogoi and Sulakshana Dutta
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Abstracts:-

The Khasi Hill District (East and West) is located in the Meghalaya Plateau of NE India and experiences the heaviest rainfall (Approx. 1200 cm/annum). The district is characterized by highly dissected topography with deep gorges and cliffs and endowed with fertile agriculture soils, good forest covers, abundant water resources, coal and limestone deposits. But all these natural resources are now grappling with the problem of environmental degradation created by the loss of forest cover, active erosion and land damage. One of the dominant factors responsible for loss of the forest cover is the Jhum or Shifting Cultivation practiced by the hill tribes of Meghalaya. The unplanned mining of coal and limestone has caused active erosion and land degradation resulting in a fragile ecosystem. This geoenvironmental studies in the area suggests extensive conservation measures to protect the forest cover, erosion and degradation of the ecosystem.

10. Rural Industrialization of North East States through appropriate technologies

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Abstracts:-

The North Eastern States of the country are full of mountain and forests, accessibility to different places is poor because of terrain. These states are filled with natural resources. But the common people are poor and their living standard is very inferior to the people of

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plain areas of the country. The majority population are engaged in limited agriculture, agro - forest and allied activities. The un-employment problem is acute which has ignited insurgency in NER. The common people of the states are still using the age old traditional tools for agriculture, food processing, space heating etc. The only way to improve the standard of livelihood of the people of NER is possible through setting of cottage and small industries for conversion of local raw materials into value added products. At the same time the improved tools and devices required for the cottage industries should be low cost and highly efficient to provide enough profit to the users, and the devices should be produced by the local artisans for sustainable development.

Regional Research Laboratory (CSIR), Bhubaneswar has developed various appropriate technologies for conversion of natural resources into value added products, aimed for small enterprises. The devices such as multi-fuel & biomass cook stoves, space heater, biomass operated drier, cardamom drier, power operated paddy thresher and winnower, bakery oven, energy efficient pottery kiln, Terafil (terracotta) water filter, heat treatment of enamel paints using biomass, pulse thresher-cum-winnower, low cost furnace for melting non-ferrous metals etc. have been implemented in some North East States in recent past. These technologies have been proved highly successful due to its technological superiority over the traditional systems and appropriate to the need of the local people. The paper will highlight the details of the appropriate technologies for understanding and large scale adoption for improvement of livelihood of common people in North East States.

11. Mathematical modelling and computer simulation for regional development

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Abstracts:-

Mathematical modelling and computer simulation provide means for focusing available scientific information on important issues of policy that have a scientific dimension. Mathematical models extract general information (e.g. fundamental laws, empirical correlation) relevant to the problem drawn from various fields (physics, chemistry, biology) in such a way that precise quantitative questions can be formulated for possible answers. They have to be supplemented by specific information (e.g. meteorological data). Computer

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simulation provides the way for integrating general and specific information for complex problems. A question does however arise whether they can be expected to enhance the value of scientific and technology inputs towards regional development.

A case study in the area of public health is given to illustrate how it can be done. A mathematical model was constructed to describe the changes in cataract blindness due to a large-scale surgical intervention programme. It was applied to seven Indian states where World Bank supported enhancement of ongoing national programme of blindness control. Simulation results for a fifteen-year period are given using data provided by Census of India and the Ministry of Health and Family Welfare. They are also compared with available results of surveys. Finally, it is argued that C-MMACS experience suggests a way of nurturing and institutionalizing such efforts for regional development in the North East India.

12. Sustained Assessment and Improvement of Medicinal Plant Wealth of North East India

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Abstracts:-

North East India is one of the hot spots of plant diversity. The region houses more than 2,000 medicinal plant species, which account for ca. 20% of the total plant diversity in the region. Though there is a growing interest and concern for overall improvement and utilization of medicinal plants of the region, only a limited number of plants so far have been studied and commercially exploited. Neither the Government nor the private sector so far has come up with concrete steps for conducting serious and systematic research on this wealth. This might be due to a lack of detailed information on these plants as well as commercial prospect in the national/international market.

As a part of systematic study, there is a need for the establishment of a regional database on medicinal plants describing every details like soil type, environment, humidity, root-vegetative-floral characterization, cytogenetical, biochemical and molecular characterization. Medicinal value of the plant as well as its parts has also to be determined

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and highlighted. To this effect, a computer programme has already been developed. Further a regional herbarium has already been set up with 700 medicinal plant species. A network of local colleges from various part of the region has also been established for a holistic approach.

Karyotype and other cytogenetic analysis of each of the plant and determination of their genome size could be taken up on priority basis for future molecular genetic application and improvement. The medicinal plants lacking effective natural multiplication have to be subjected to tissue culture for easy and faster multiplication. Standardization of suspension culture could be one of the sustainable propositions for the production of active compounds as secondary metabolites.

Biochemical analysis with the isolation of active compounds, their identification and pharmacological assessment will ensure medicinal worth of the plants concerned. Thin Layer Chromatography, High Performance Liquid Chromatography, Gas Chromatography-Mass Spectroscopy, Atomic Absorption Spectroscopy and Nuclear Magnetic Resonance assisted analysis would strengthen the biochemical analysis of active compounds. Genome analysis with the construction of cDNA library could lead to exploitation of genes involved in the biosynthesis of active compounds of the medicinal plants. However, there must be a coordinated approach between various research institutes from both public and private sectors for sustained analysis and improvement of medicinal plants

13. A study of pre-monsoon convective activity over North East India with special reference to Nor'westers

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Abstracts:

The knowledge of the intensities, distributions and movements of pre-monsoon storms due to cumulonimbus clouds leads to predictable patterns of their future development besides giving an insight into the atmospheric processes inherent within the system and

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consequently is complementary to the understanding of the regional and global climate system. Here in this paper we present our initial investigations on the interactions between atmospheric conditions and climate in the North Eastern parts of India during the pre-monsoon season which modulates the intense rainfall events in the flood-prone plains of the region ,which again, is a climatically marginal band on the eastern fringes of the Himalayan mountain range. In this study an attempt will be made to correlate theoretical studies of these intense atmospheric processes with, the experimental observations by local and remote sensing techniques.

14. Status and Strategies to Evolve Yak Products' Process Technologies for Economic Upliftment of poor Yak herdmen

By
Mohan bhattacharya
Director

15. Process Automation in Tea Industry

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16. Polyvinyl Alcohol as Taste Sensing Material

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Abstracts:-

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There are reports of taste sensor fabrication by incorporating different lipids in PVC matrix. We have taken an attempt to prepare taste sensor material by using functional polymer. Polyvinyl alcohol has been modified to fabricate the sensor material. The research work covers polymer membrane preparation, morphology study, and structural characterization of membrane and study of the taste sensing characteristics. Polyvinyl alcohol membranes were prepared in different ways to get suitable thickness with good sensitivity and less swelling in water. FTIR spectroscopic analysis, SEM study, XRD analysis etc. have been done to get an idea about morphology and composition of the polymer membranes. Taste sensing characteristics of the prepared membranes were studied for varying concentrations of hydrochloric acid, sodium chloride, sucrose, monosodium glutamate and quinine hydrochloride. Reproducibility of the taste sensing characteristics of the membranes was also studied

17. Role of Sericulture for Regional Development

Satyendra Nath Kalita
Manoj Kr. Rajbangsi
Sushil Sarkar
Bajali College
Pathsala

Abstratcs:-

Sericulture has been considered as an industry of poor people. It has Played an important role in economic life of man even since its discovery more than 4000 years ago.
In a developing countries like India , it is essentially a village base and welfare oriented industries capable of providing employment to large section of the population. There are ample scopes for the sericulture practice in the tribal areas of Assam. Generally its practice is done by the tribal people some corner of the state without scientific knowledge and technology .Thus Science and technological innovation can make it possible to practice sericulture on an intensive scale , providing greater employment opportunity as well as profit then agricultural crops.

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18. Ionic Conductivities of Natural Silk, Cotton and its comparison with Synthetic one

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Material Sciences Division, Polymer Unit, Institute of Advanced Study in Science and Technology, Khanapara, Guwahati-781 022

Abstract:-

The ionic conduction data and nature of the some of the well known silk like Muga, Eri and Tasar were compared with cotton and synthetic cloth in this paper. The ionic conductivity of different types of Muga was also compared. The material was placed in between two stainless steel plate used as electrode and the conductivity was determined from 30 to 100^{o}C. The data showed that they are less ionic than the synthetic fibres and thus they are better for health along with other quality like course texture, thermal and UV properties. The ionic conductivity of fine Muga is ranging from 9.866x10^{-11} Scm^{-1} at 30^{o}C to 4.673x10^{-10} Scm^{-1} at 100^{o}C. The conductivity was determined under a relative humidity of 57%. The IR spectra of these materials were also compared.

Keywords. Ionics, Silk, Muga, Eri, Tasar, Cotton, Conductivity.

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19. Public Service through Education, and Research related to Weather and Climate

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Abstracts:-

Main theme of this talk is to present an example in the U.S. where education, training and academic research can be used to serve the public in a variety of applications. These

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include agriculture, emergency response, water resource management, economic development, air and water quality, and tourism to name a few. The State Climate Office of North Carolina is the primary source of weather and climate information for North Carolina. The NC CRONOS / ECONet Database developed by the State Climate Office of North Carolina, enables the public to quickly and easily retrieve archived weather observations from 200 stations in and around North Carolina.

The State Climate Office is continuously investigating weather and climate in North Carolina. North Carolina has a very appealing climate, and the weather here is a large reason why so many people are moving to live in this area. But we also have our fair share of severe weather, and it is critical to understand patterns in severe weather to protect the lives and property of our citizens. For this reason, the State Climate Office studies the history of severe weather in North Carolina. An analysis of the climatology of tornadoes in North Carolina for a period of fifty years (1950-1999) was performed using tornado data obtained from the National Climatic Data Center (NCDC) and the National Severe Storms Laboratory (NSSL). The data was examined spatially using a Geographic Information System (GIS) to illustrate tornado patterns across the state. Other research that directly benefits the state include tropical cyclones, ElNino / La Nina events, air pollution, and climate change. Examples of academic research helping different state agencies will be presented.

20. Electronics Governace Facilitator to E-Busines

Sharma I K

Abstract:-

In simple terms Electronic governance can be defined as giving citizens the choice when and where they access the government information and services. While e-governance in case of processes used to provide services to the public, e-government is the tool to accomplish e-governance which not only facilitate these results in providing the information and various services but the total process of functioning becomes more efficient and productive as well as transparent which is very conducive to the business. To a greater extent, it aims at eliminating delays in getting Government approvals, register the legal transaction and provides various sanctions and services based on the rules, which adds to transparent functioning. At times it is called smart Governance. In the process, it is helpful to the citizens as well as Government and State which becomes more

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prospective and it helps in identifying the pocket of inefficiency which is helpful to the administration. Henceforth the smart Governance constitutes the following factors:

1 Simple
2 Moral
3 Accountable
4 Responsive
5 Transparent

In order to have the knowledge of factual data of the State regarding the quantum of business, natural resources of the state, educational levels, poverty level, infrastructure of the state, e-governance is very effective measure which may be adopted in true spirit. Over and above it promotes scientific temperament and a positive attitude.

21. STATUS AND STRATEGIES TO EVOLVE YAK PRODUCTS' PROCESS TECHNOLOGIES FOR ECONOMIC UPLIFTMENT OF POOR YAK HERDME

Sharma[2] D K and Bhattacharya M

Abstratcs:-

Introduction

Yak is a versatile and unique animal. It gives milk, wool and meat to highlanders, and serve as "pack animal" in snow bound hilly tract. It directly provides food, clothing and shelter and indirectly (through trade) yields grain, tea, and ironware and other manufacture goods such as sneakers, aluminum pots and clothing to Yak herdmen. Highlanders are completely dependent on Yak for their livelihood. This economic dependence is very much signified in the nomad's generic term for yak, which sounds as 'Nor-a', that normally, translates as "Wealth".

Male Yak is extremely powerful and has great endurance even at the highest altitude. It is the only animal that can carry the nomads' heavy and bulky black tents, each side of which weigh about 100 pounds, and do so through snow and crossing passes at 20,000 ft and higher.

For stainable Yak farming at higher altitude under Nomads' traditional set up, we have to evolve innovative strategies for higher economic returns per animal or per herd.

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The basis for any economic activity to continue and grow is nothing but its own strength to earn profit. All research and extension efforts should therefore be focused on increasing the profitability of existing Yak farming system. This article is focused on innovative strategies for increasing the productivity of Yak; and higher economic returns from traditional Yak farming.

Yak Milk and Milk Products

Yak Milk

Jain and Yadav (1985) and Gupta *et al* (1997*),* in their studies on yak milk composition, reported that the mean value of yak milk consisted of 6.43% fat, 17.93% total solid, 11.50% SNF, 5.94% total protein, 0.87% ash, 0.60% total nitrogen and 0.46% casein nitrogen, 0.04% non protein nitrogen, 4.68% lactose, 0.30% calcium, 0.74 mg/100ml iron, 122.50 mg/100ml potassium, 70.50mg/100 ml sodium, 0.29mg/100ml phosphorus along with pH 6.64, titratable acidity 0.17 and specific gravity 1.04, respectively. Therefore there is tremendous scope to work on the development of process technologies for making dairy products from yak milk available in this part of India

Yak plays an important role in the socio economic and cultural life of people inhabiting the alpine region in the Himalayas, where the **major source of income for the yak farmers comes from yak milk.** The milk production of Yak is low, averaging only 100-300 Kg/lactation, yet its milk is one of the richest sources of fat with a range of 5.8 to 7.9% (Jain and Yadav, 1985; Gupta *et al*, 1997; Sharma *et al*, 2003)

TRADITIONAL YAK MILK PRODUCTS

The yak farmers do not consume milk as such, rather they convert, summer milk abundance into butter and cheese (churpi or white farmers cheese) by traditional methods (Raquib *et al,* 2003)

> **The** churpi **or cheese is a delicious item made from yak milk by traditional method in an indigenous cylindrical churner made of wood and bamboo strips. However, this indigenous method of making churpi does have disadvantage of post product contamination. The technology of churpi making is one of the low cost technologies developed by the people and is well adopted by the people of the highland. Pal *et al* (1996) in their study on physical characteristics as well as bacterial load of Churpi (local yak wet cheese) at different storage days revealed that the dry matter percentage**

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ranged from 24-52%, consistency ranging from soft, hard and slightly hard, color white to orange, taste and odour –sour to pungent, pH 5.97-7.0 and bacterial load 38.75X1000 to 11.9X10000.

A by- product of Churpi making process is whey. Boiling whey until it becomes a dark and thick concentrate makes **Doja**. Some of this is applied immediately (with a small tuft of wool) on face while the rest is stored in a can or wood box. A single batch of Doja can last for weeks or even months. Reusing it is simple. A few drops of water are added to the thick concentrate, which is then reheated at the edge of the fire. Doja is carefully applied by women on their forehead, nose and cheeks with a small tuft of wool.

Recent Trends and Scope of Yak Milk Products

Yak milk products are not well developed and the traditional ones are not competitive. There is need to further develop these products and to adapt packaging and brand naming in order to facilitate target marketing. Yak milk is considered as organic food with no chemical inputs in form of animal feed additive, veterinary drugs, etc., and therefore has huge marketing potential in the western countries.

Very little research work has been conducted in the field of process technology for making dairy products from yak milk. However, countries like China, Bhutan, India, Mongolia, Pakistan and Nepal have developed some indigenous and traditional technologies to produce yak milk products (Thapa, 2002). These technologies however, do have some limitations regarding wholesomeness as well as prolong shelf life of the products.

In Nepal, yak milk is primarily used for making cheese and butter by their traditional methods (Joshi and Lund, 1994). Thapa (1996) had stated that Nepal is the first country in Asia to manufacture Swiss Gruyere type cheese from yak milk, which is being marketed in the brand name of " Yak Cheese".

Cai Li and Weiner (1995) reported that fresh yak butter comprises of 72.60% fat and 232 mg/100gm cholesterol which is lower as compared to cow and buffalo having 81.92 and 80.30 % fat and 313 and 275 mg/100gm cholesterol, respectively. Churpi, a local product made from yak milk comprises of 55% protein and 21 % lactose as reported by Cai Li and Weiner (1995).

Pal *et al.,* (1996) in their research on churpi (a wet yak milk cheese) stated that dry matter, colour, physical consistency and odour varied on prolong storage period while pH of the product varied from 4.50 – 7.00 and bacterial load varied from $1.30X10^3$ – $94.06X10^4$ / gm dry sample.

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Yak Wool and Its Products

One of the non-food raw product from yak with significant scope for value addition is Yak wool or fibre. Like other ungulates native to cold region (viz., Reindeer and Mask Ox), the yak also possesses two coats. The outer coat consists of course guard hair and soft hair of intermediate thickness and the finer under coat of down fibers. The down fibre of yak is like pashmina or mohair of goats.

The shedding of down coat in young animals, and intermediate and down coat in adult yak starts from May and continues through July. This process of natural shedding of down fibre is called “moulting”. Yak, both wild (*Bos mutus*) and domesticated (*Bos grunniens*) moult for the sake of adaptation against the environmental heat in summers, and fresh coat comes up before winter. There is wide variation reported in the yield of yak fibre. Weiner (1995) reported that in general the yield of hair in Henduan type alpine yaks is much higher than that in plateau type yak from lower elevation. Singh (1987) reported an average yield of 1.0 to 1.5 Kg of coarse hair, the corresponding yield of finer fibres varied from 100 to 600 gm per animal annually. Patni (1993) reviewed that an Indian yaks yield 750 to 1400 gm of hair and about 500 gm wool per year. Pal *et al.,* (1994) reported that yield as 0.4 to 0.6 Kg of down fiber and 0.3 to 3.0 Kg of coarse hair per animal annually. There is great scope of increasing the production of yield through selection. The yield of yak fibre is greatly affected by yak breeds, topography of mountain region, sex, age, and season, and method of harvesting.

The income to the yak herder from the sale of raw yak hair and down fibre is very low as compared to that obtained from yak milk and milk products. To improve the economics of yak fibre, and for better economic returns from fibre, there is need to make value added products from yak fibre adopting modern technology, and organized sale.

The quality of under coat fibre of yak is very fine and there is great scope to make value added products from yak wool such as shawl, caps, fabric and other woolen garments having great demand in the market. The coarse hair from upper coat is good for making carpets and other decorative hangings and upper covers. Traditionally, the hairs are used for making ropes, blankets, bags, and tents for daily use by the herdsmen

The research on these lines will generate information on the quality of fibre, which would be latter- on used for fixing national and international standards for yak wool products. The standards are required for organized marketing with a check over the existing simulated market products.

Economic Importance of Raw Yak Products (RYP) and Research Strategies

The economics of RYP in traditional yak farming is well established. The traditional yak husbandry sustained because of the positive economic returns from the sale of milk, wool and meat. Presently there is stress on the forestland and good grassing pastures for the yak, which are decreasing day by day. The profitability of the traditional yak framing is diminishing in comparison to other options available to the farmers/ herdmen. If the economics of the yak farming in traditional system is not addressed properly then in year to come no yak farmer will keep the Yak, rather they will prefer to go for alternative animal farming at lower altitude (the winter settlements) for better returns. This trend can be reversed with the intervention of science so as to enhance the economic gains from yak rearing system. To achieve higher return per animal or per acre of pasture land the research strategies are to be formulated on two watch words i.e. *productivity* and *value addition*.

Critical Research Areas

The research must provide answers to the following questions:

How to increase yak milk production per animal per day?

How to increase the yak wool production per animal per year?

How to increase the number of Yaks per acre land every year?

How to increase economic returns of Yak herdmen from raw yak products?

How to maintain ecosystem with sustainable growth in alpine region?

How to strengthen traditional yak farming and yak tribal culture?

Research Strategies and Priority Projects

Our research strategies must address the *aforesaid* questions in holistic manner without the boundaries of subject specialization. Our approach should be interdisciplinary to find answers and solutions. The research should target to evolve technologies for increasing the yak productivity and economic returns per yak per acre land per year. Some of the exemplary research project titles may as follows:

For Productivity Enhancement

- Critical inputs and technological interventions through “off campus” training of yak herdmen for improving yak productivity under traditional yak farming system in mountainous region.
- Scientific evaluation, improvement/ modification and application of ethno-veterinary practices prevalent amongst yak herdmen.

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- Studies on the development of model feed and forage management system for rearing yak particularly in lean season.
- Studies on the yak hybrid productivity.
- Studies on development of model-integrated animal farming system for yak farmers at mid altitude.
- Studies on the evaluation of yak productivity by improving their germ plasma and management.
- Studies on ecofriendly (green/organic) traditional and alternative (Homeopathic and Ayrurvedic) medicines for yak health and treatment.

For Value Addition

- Development of process technologies for making dairy products from yak milk.
- Standardization of Yak Wool Processing Technique for making quality carpets and shawls**.**
- Studies on Carcass yield and certain meat quality characteristics of yak
- Development of infrastructural facilities and institutional framework for production, collection, transportation and processing of raw yak products (milk and wool) from tribal herdmen, and marketing of the processed products

Salient Achievements and Technologies Developed at LPT Unit, NRCYak

- Established a small yak milk-processing unit with a capacity to handle 5-10 kg milk/day for demonstration, model system analysis and long term trainings.
- Developed process technologies for production of value added milk products:
  - Starter culture for yak dahi making
  - Yak milk Dahi
  - Yak milk Paneer
  - Yak milk Khoa
  - Flavoured milk and Lassi
  - Whey Beverage
  - Yak milk sweets
- The value addition through these technologies is 2.5 times.
- The technologies were passed on to the tribal people through long-term training programme organized at NRCY, Dirang.
- The small milk-processing unit manned by the tribal trainees generated a gross income of Rs. 50,000 in nearly six months. The unit is being run on commercial basis.

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- Developed process technology of making yak meat sausages.
- Established yak wool processing and handicraft making unit for demonstration and training. The unit is being run on commercial lines.

The Ultimate Strategy

Interdisciplinary- Inter institutional Resource Management & Development Project

(Priority Research Project: Model System Application & Analysis)

Aims and Objectives

- To improve the production output of raw yak products (milk and wool) under traditional yak farming setup.
- To develop infrastructure facilities for collection, transportation and processing of raw yak products under cooperative institutional framework.
- To develop model system to market processed and finished yak products in national and international market under cooperative set-up.
- To develop modern training facilities and institutions for transfer of technology to yak herdmen in scientific yak husbandry practices, and processing of raw yak products.

Tangible Benefits

The project is basically aimed to enhance the gross income of tribal yak herdmen from the yak-processed products under cooperative institutional network. The successful implementation of the project shall increase the farmers' income. The production of yak milk and wool would increase to at least double. There will be significant increase in the number of yaks per unit area under project.

- The cooperative institutional network (CIN) for collection, transportation and processing of raw yak product is expected to enhance the gross farming income per yak at least two times or even more.
- CIN marketing of processed and finished yak products direct to the consumers shall further increase the earning/ gross returns of the tribal herdmen.
- Training in scientific yak and integrated farming will improve the knowledge and skill of poor herdmen, which will in turn be used to improve the productivity of yak. More and more tribal families will be motivated and mobilized to start yak farming as business.
- Training in raw yak products processing techniques is expected to generate employment for tribal youth in milk cooperative and private enterprises. It will

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stimulate the balanced and sustainable growth of cooperative enterprises in general and milk processing in particular under traditional yak milk production system.

- The project will generate direct employment for tribal youth in different segments of business: Yak Milk Production (300-400); Collection (10-15); Transportation (8-10); Processing (20-30) and Marketing (20-25).

Intangible Benefits

- *Social Benefit*

The poor yak herdmen families in the project area shall be the beneficiaries of the project activity not only economically, but also socially and culturally. This neglected and under developed area in upper Himalayas shall be economically lifted with the help of their age-old environmental friendly traditional yak farming practices. More and more people will be attracted to start yak farming, and shall not depend on the rain forest for their livelihood. The green forest shall be saved from human onslaught.

- *Environmental Benefit*

Traditional yak farming practices are ecofriendly with high altitude Alpine forest and pastures. Because of this wonderful animal, the yak, the snow bound area (3000-6000 m) has some green vegetation. Yak farming is essential for sustainable economic growth as well as protection and growth of green pasture and forest. In absence of the activity (yak farming), the people of the region bound to depend on forest wood for their livelihood. Yak farming is the only ecofriendly technology for the social, cultural, environmental and economical upliftment of the tribal yak herdmen.

CONCLUSION

For making traditional yak farming (an eco-friendly and organic/green technology) a profitable business for economic upliftment of small and poor tribal herdmen, and to sustain yak husbandry in upper Himalayas, it is utmost important to apply our research findings and the available technologies for getting higher economic returns from traditional yak farming. The scientific intervention should be minimum and synergist in strengthening the age-old practices.

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22. Fresh Ginger Processing - RRL Experience in the North East

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Abstract :-

Regional Research Laboratory, Trivandrum is actively involved in the development of the north east and have set up commercial unit for processing fresh ginger in the hill district of Ukrul in Manipur. The laboratory is currently involved in setting up another unit in Meghalaya based on the technology developed by the laboratory to process fresh spices to obtain the essential oil with out going throught the drying operation. The technology is very much relavant to the region and have been transfered to six parties all over India and will enable to transform the region into an internationally competetive center for spice oils and oleoresins.

The technology has won the NRDC National Technology Day Award 2003 and is expected to replace the conventional technology for spice oils and oleoresins because of the technological and cost advantages. The papaer aims at discussing the RRL experience in such technology ventures in the North East and the commitment of the laboratory to undertake such ventures as well as the novel approach whereby the fresh spices are processed to get the flavour compounds. The new process will result in enhanced essential oil recovery which otherwise would have lost during the drying operation. The product obtained by the new process have better flavour due to the retention of the low boiling volatiles. The process has application in the recovery of oil and oleoresin from Pepper, Turmeric, Ginger, Chilli and other spices.

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23. Prospects of Platinum Group Element (PGE) occurrence in the Ultramafic rock associations of the Naga Ophiolite Belt, North-East India: need for detailed investigations

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Abstracts:-

Naga Ophiolite Belt occurring in the North-East India is among the very few ophiolite belts of India and consists of mafic-ultramafic assemblages, apart from the other usual rock associations that normally occur in an ophiolite belt. There are earlier reports of the occurrence of chromite, magnetite, limestone etc in this belt. High platinum group element (PGE) concentrations are a feature of chromite-rich rocks worldwide, irrespective of whether they occur in the ophiolitic sequences, in Alaska-type ultrabasic complexes, or in stratiform intrusions.

Since the Naga ophiolite belt consists of considerable extent of ultramafic rock assemblages, often in association with attendant chromite ^Ömineralization at places, concerted efforts have to be made to study the PGE geochemistry of the ultramafic rock assemblages and the chromites of the belt. These studies will help in constraining the tectono-magmatic affinity of the belt, apart from realizing the prospects of PGE mineralization. The ultramafic assemblages of the belt include dunites, harzbrugites, lherzolites, serpentinites and pyroxenites which could form the potential PGE bearing assemblages. These ultramafic rocks were found to be cumulates by their overall geochemical signatures.

Preliminary results of our studies on the PGE geochemistry of the ultramafic assemblages indicate total PGE levels ranging from 33.8 to 209 ppb, warranting further detailed investigations in the belt particularly on the horizons bearing chromite mineralization. Establishment of the occurrence of precious metals in the ophiolite belt will go a long way in enriching the lives of the people of the region in particular apart from adding a discovery of a precious resource to the national wealth, since most of the PGE being consumed in the country now is met from imports.

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24. Separation of Phenol from Aqueous Solution by Pervaporation using Polymer Membrane

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Abstracts:-

Pervaporation is a membrane separation process in which a liquid mixture is in contact with the membrane on the feed or upstream side at atmospheric pressure and the permeate is removed as vapor from the downstream side by applying vacuum. This technique operates on the principle of selective permeation of a volatile organic compound through the membrane and subsequent evaporation of the permeate. Over the past decade membrane pervaporation has gained acceptance by the chemical industry as an effective process tool for separation and recovery of liquid mixture. This technique is also being utilized for the removal of toxic organic compounds from industrial effluent.

It is understood that better efficiency in pervaporation separation is dependent on the membrane composition and its morphology. In order to use tailored membrane for such separation we are developing some polymer membranes for selective separation of organic compounds form its solution. In the present investigation with an objective to standardize membrane composition and its morphology we prepared different membranes. As a test case we have taken aqueous phenol solution for separation of phenol using such membrane.

Two types of membrane were used in the present work. One is hydrophobic and other is hydrophilic. The hydrophobic membrane is interpenetrating network of poly (methyl methacrylate) and HTPB based polyurethane and the hydrophilic membrane is cross-linked poly (vinyl alcohol). These membranes were used in both batch and continuous pervaporation processes.

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The hydrophobic membrane showed high separation factor (~400) and ~80% phenol concentration in permeate. The membrane has high selectivity towards phenol compared to the HTPB based polyurethane. The hydrophilic membrane shows high selectivity towards water and gives more water in the flux. Different pervaporation parameters have been measured and results are discussed.

25. NORTHEASTERN INDIA : Tectonic Setting, Hazard Potential and a unique Testing Ground of Scientific Hypotheses

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Abstracts:-

Norheastern India is one of the few samples of the globe where Nature's works are manifested on a grand scale. These, in turn, expose the region to frequent paroxysms of the earth system whose dynamic states often excurse to extreme conditions creating natural hazards. At the same time, they also provide scientists with unique opportunities for exploiting their extraordinary diagnostic potential for unravelling the intricate workings of earth system processes generally, as well as, learning to design effective measures to enhance our ability to cope with their adverse impacts. A physiographic map (Fig.1) of the region shows how the region is acutely wedged between two nearly perpendicular topographic highs of the Eastern Himalaya and the Indo-Burman ranges. The orography formed by them, acts as a veritable attractor for the summer monsoon, making the region one of the rainiest on the globe with attendant high rates of erosion and almost recurrent flooding, whilst the ongoing tectonic processes that sustain the mountain relief by persistent compression, steadily accumulate elastic strain to be periodically relieved by great earthquakes. This steady compression finds eloquent expression in the
almost incessant occurrence of small tremors and occasional moderate ones that, in turn, raise anxious forebodings in the minds and consciousness of scientists, planners and the people generally. Fortunately, however, technological solutions to effectively mitigate the disastrous consequences of these natural hazards are either available or can be designed if

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the basic knowledge products required for robust and resilient designs of mitigation measures can be generated through well conceived experiments and rigorous computer aided analysis and visualizations.

TECTONIC SETTING

Since earthquakes are known to be the outcome of fracturing in the earth's outer brittle domains, a seismicity map of south Asia (Fig.2) unmistakably delineates the fracture systems that bound northeastern India: the Himalayan and the Indo-Burman arcs of the Alpide- Himalayan orogenic belt, both straining towards a northeast syntaxis truncated by the south-west directed Mishmi thrust (Fig.1). Its exposed geology, albeit less well explored because less easily accessible, is compatible with the outcome of successive earth processes (Appendix) that followed the initiation of the Gondwanaland break-up around 280 million years ago, i.e., sequential collision of its northward drifting fragments with south Asia. The first relatively narrower continental fragments stripped from northern Gondwanaland, thus accreted to south Asia (Fig.3) continually modifying
and reforming its southern ramparts till around 45 million years ago, when one of the largest fragments, the Indian plate, rammed into it (Fig.4), wrapping the latter around itself through continued penetration that persists to this day. Prominent structural features of the region have since been fashioned by this unabated continental collision process at the adjoining plate boundaries and consequent tectonic outcomes of the resulting compression behind them. About half of the ~40mm/yr northward advance of the Indian plate with respect to Eurasia (Paul et al, 2001), is apparently accomodated by its nearly arc -normal underthrusting of the Eastern Himalaya along the Main Boundary thrust (MBT) and the inflected Mishmi thrust whose southeastern extension passes into the N-S dextral Sagaing fault. These three together constitute the northern and eastern boundaries of the plate. Behind these boundaries, persistent compression modulated by earthquake cycles , have generated and most likely continue to sustain, thrust faulting, creating the diverse structural features of the region and its tectonic ambience: the Eastern Himalaya, the Indo-Burman ranges, the Shillong -Mikir Hills Plateaux and across their tectonic boundary (the Dauki-Haflong-Disang fault system) , the Bengal basin.

The most spectacular tectonic feature of the region, the Eastern Himalaya, consists of a stack of east-west striking thrust sheets (Fig.5), more or less uniform in geological

composition and thickness along the arc. The Main Central Thrust (MCT) separates an upper sheet, comprised of crystalline rocks of the Great Himalaya from a lower sheet of meta-sedimentary rock in the Lesser Himalaya . Both sheets, in turn, have been thrust on top of the Indian shield along the Main Boundary Fault and splays from it, in response to India's underthrusting of Tibet (e.g. Gansser 1964, LeFort 1975}. That this process continues by slip on the southernmost Main Boundary fault system, visible in the seismic reflector images of southern Tibet (e.g. Nelson et al. 1996), is testified both by well constrained focal mechanism solutions of regional earthquakes (e.g.,Baranowski et al 1984, , Ni and Barazangi 1984, Molnar and Lyon Caen 1989) as well as GPS Geodesy (Bilham et al 1997).

The second prominent structural feature of NE India , is the elevated block of the Archaean-Proterozoic basement exposed in the Shillong plateau and Mikir Hills, the former rising more than 1.5 km above the Bangladesh plains. These are bound on the south and east by the north dipping (Bilham & England, 2001) Dauki-Haflong-Disang fault system which also mark the northern limit of the Sylhet trap basalts of Cretaceous age(~120 Ma), that flowed extensively in the region during the sundering of the Indian continent from Antarctica . This fault system thus appears to have predated the Sylhet traps and later facilitated the uplift of the Shillong plateau by engineering a complementary one on the northern edge of the plateau (the Oldham fault of Bilham and England-2001). Indeed, the Shillong plateau is estimated to have been upthrust by ~18 km along this fault (Fig. 6) based on seismic soundings of the top of thesubmerged Sylhet limestone in the trough south of the Dauki fault (Hiller, 1988), at a depth of 15 km with respect to its exposed section north of the fault.

Other significant geological features of the region are the Brahmaputra valley occupying the foredeep and the Bengal basin. Except for a few basement outcrops astride the lower Brahmaputra, the valley is covered by gently dipping Tertiary sedimentary rock and later alluvium of increasing thickness to the north and east. Nandy and Dasgupta (1986) used satellite images to delineate a number of buried lineaments under the alluvium. Prominent among these are the E-W Brahmaputra Fault along the northern edge of the Shillong plateau, almost paralleling the river, and the NW-SE Kopili river lineament intervening the plateau and the Mikir Hills. The Bengal basin, including the world's largest delta, is mostly

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covered by recent alluvium underlain by a complete sequence of Tertiary sedimentary rock, thickening eastwards to ~20 km. Geophysical surveys and deep drilling in the region, have enabled a detailed characterization of its sedimentary section, and mapping of buried basement ridges has led to models of its tectonic development (Dasgupta et al 2,000). To the east, the Indo-Burman fold and thrust belt emplaced over a recently subducted Indian plate to the east, actively overthrusts the Indian continental basement and its Palaeogene-Neogene cover along a Schuppen zone creating shallow and moderate earthquakes in the region (Chen and Molnar, 1990).

KINEMATICS AND STRUCTURE OF THE UNDER-CARRIAGE : Recent results

Recognizing the immense impact mitigation value of quantified earthquake hazard for high risk areas as a prerequisite quantity for hazard resistant design of construction codes and practices, a number of research programmes were recently initiated in northeastern India. These are aimed at gaining knowledge of the basic structural and tectonic framework of the region, in particular, of a) the elastic structure of what lies underneath, using ultra high fidelity seismographs, and b) the annual surface deformation field with a precision of a few millimetres, using Global Positioning System (GPS) receivers. The latter constitute the ground surface observables whose subsurface cause i.e., the strain and dislocation fields underneath, is sought to be defined for estimating
the critical parameters needed for computing probabilistic hazard figures at various sites of the region . The elastic parameters of the region's undercarriage structure , provide a realistic image of the model in whose context the observables are inverted to yield the sub-surface strain and dislocation fields.

Shillong is the only site in the region so far, for which we have a first order GPS based deformation rate. This in conjunction with data from Bangalore and Lhasa indicates that convergence in Eastern Himalaya is , on average, the same as elsewhere along the arc (Fig.7; ~ 18mm/yr) . This would imply strain accumulation at the rate of ~5.4 metres in 300 years, enough to generate a great earthquake of magnitude 8. Although our knowledge of great earthquakes in the region prior to 19th century is poor, it is clear that major strain relief over the past 300 years or so , has only occured along the ~200- 300 km northeastern extremity of the Eastern Himalaya during the 1950 great earthquake. On a conservative estimate , therefore, the region further west facing Assam and Bhutan has, most likely, over 5 metres of strain waiting to be released (Bilham, Gaur, and Molnar, 2001).

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Within the region, outside the plate boundary thrusts, seismicity rates have been known to be relatively higher around Diphu and Nowagong, and the buried Kolpili lineament revealed by satellite imageries appears to be a significant feature that may be associated with transverse segmentation of the Himalayan arc preparing for the next great strain release and earthquake. However, to be able to define the strain field more precisely, we need GPS derived site velocities at hundreds of sites in the region with some acting as reference stations monitored around the clock. Over the past year C-MMACS scientists, with a generous grant from DST, have helped establish 8 permanent GPS stations in the region (Fig. 8) in collaboration with scientists of the host institutions, who ,additionally, have DST supported projects to cover their respective neighbourhood areas with the objective of mapping the annual strain fields. This constitutes a remarkable scientific infra-structure which should enable us to have a high precision annual strain field map of the region within about 5 years. However, considerable computational work will be required to analyse the vast data set that is being currently generated and it is hoped that academic and research institutions in the region will embrace this exciting and rewarding task.

Recent studies based on the analysis of broad-band seismic data from a ~ 40 km wide north-south strip of the region from Agartala to Bomdilla and further north upto Lhasa, have highlighted some extremely important aspects of the structure of the region's under-carriage (Fig.9). Apart from its obvious value to modelling hazard quantities in the region, these images have important implications, generally, to the disposition and strength characteristics of earth materials at depth, that few continental collision sites on the globe have the potential to reveal.

A SCIENTIFIC AGENDA FOR NORTHEASTERN INDIA

Modern computer algorithms have made it possible to employ the formalisms of advanced mathematical analysis in the abstraction and interpretation of meaningful signals often buried in a mass of data if they happen to be of high enough resolution (Fig. 10). In the past few years, the Department of Science and Technoliogy, Government of India, has made massive investments in establishimg permanent Global Positioning System (GPS) , and ultra high fidelity seismic stations in northeastern India coupled with specific research projects sanctioned to scientists of host institutions with the objective of creating a fairly broad base of observing systems and scientific expertise in the region. Given the network of

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such permanent monitoring stations at the 5 University Centres of Tezpur, Gauhati (Fig.11), Mokukchang, Imphal and Aizawl, together with India Met department's Shillong and Pant Institute's Gangtok stations which, when operating uninterrutedly, generate close to 500 Mb of digital data every day. Rigorous analysis of this massive data set over the next few years should enable us to extract seminal features of the deep structure of the region and of its elastic strain and dislocation fields which provide the basic quantities needed to compute hazard figures in different parts of the region over desired future time windows to guide the optimal design of safe structures, in addition to illuminating the , as yet dimly understood, details of the continental collision process generally, that operate in other parts of the world but not dramatic enough to be easily discernible.

A common experience, however, shows that whilst it is relatively simpler to instal and operate the most sophisticated systems available, our analytical abilities are woefully inadequate to process, refine, and interpret these data sets, with precisions commensurste with the data quality and information content. Furthermore technological inadequacies result in unwarrantedly long failure durations with attendant loss of valuable data, whilst our inability to archive data at a central location in an easily retrievable form for joint analysis of synchronous but spatially distributed data sets relating to specific events, preclude a deeper analysis and interpretation.

Two main issues of an immediate scientific agenda for academic and research institutions in northeastern India, can thus be readily identified. Firstly, there is an urgent need to generate advanced level S&T manpower especially prepared for engagement with higher level mathematical analysis and computatonal mechanics to squeeze all useful information from observables of various environmental parameters including GPS, Seismic as well as a host of satellite data sets pertaining to this region, available through the ISRO-NEC initiative. Complementarily, there is also a keenly felt need for developing S & T human resources in the fields of Telecommunications and Information Systems to design, operate, handle, and manage digital data Archives with automated retrieval facilities.

With about a dozen universities in the region, including 4 Central Universities and an I I T, these goals may not be difficult of achievement, if a long term vision and strategy for the design of S&T expertise and capabilities in northeastern India, is created and implemented that would serve the real -world contemporary and future requirements for the creation of Knowledge products needed to ensure a wholesome and sustainable society marching into

the future without trauma. With active collaboration between these institutions and other national institutions, notably the Centre for Mathematical modelling and Computer Simulation at bangalore, which this Workshop symbolizes, the opportunities and possibilities of accomplishing these goals are potentially immense.

FIGURE LEGENDS

Fig.1 shows the physiographic outlines of Northeastern India. Lines stippled with triangles mark the surface exposure of thrust planes (fracture). The south to north line from above Agartala to the Tibettan Plateau marks the profile underneath which the elastic structure of the region (Fig.9), has been determined from the analysis of shear wave echoes (shown for Gauhati in Fig. 10)

Fig.2 Map of earthquake epicentres of siouth Asia from 1900 to 2001. Clusters of earthquakes mark the fracture systems shown in Fig.1

Fig.3 shows the southern rampart of Asia about 70 million years ago (late cretaceous), 25 million years before the Indian continental plate came face to face with the former.

Fig.4 Shows the Indian continental plate already sutured to southern Asia and still ploughing into it, at around 20 million years before present (early Miocene)

Fig.5 Shows the context of northeastern India in the Indian plate underthrusting the Eastern Himalaya towards north and the Arakan Yoma towards the east. The lower figure shows the sequential creation of fracture systems and stacking of fractured slivers (thrust sheets) to form the Eastern Himalaya.

Fig.6 Shows a schematic cross secrion of northeastern India along a north-south profile proposed by Bilham and England (2001), since confirmed by Mitra et al (2004) shown in figure 9

Fig.7 A schematic showing the partitioning of the annual Indo-Eurasian convergence of ~ 40 mm, between the kinematics of of the Indian plate south of the Himalaya and that further north, within the belt and across in Tibet, based on GPS measurements in Ladakh and Kumaon Himalaya as well as Shillong, with respect to Bangalore.

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Fig.8 Shows the sites of permanent GPS stations established in northeastern India by C-MMACS in collaboration with scientists of the host institutions.

Fig.9 Shows the configuration of the first order Mohorovicic discontinuity and other features of the crust of noetheastern india from Cheerapoonji to Bomdilla and further north upto Lhasa, based on analysis of Receiver Functions abstracted from teleseismic records generated at the respective sites marked by triangles. Receiver Functions are shear wave echoes from subsurface reflectors which mark a change in elastic parameters. These are isolated from the much larger background of their Primary wave generators by deconvolution of the P-waveform from the horizontal component of the seismogram.

Fig.10 Shows the Receiver Function of a teleseismic event recorded by the Gauhati University broad-band digital record - courtesy: Professor Dulal Goswami

Fig.11 Shows the picture of the permanent GPS installation in the campus of Gauhati University.

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Appendix :

Around 280 Ma ago, the Gondwanaland supercontinent centred around the present location of Antarctica, primarily made up of pre-Cambrian metamorphics fringed with meta-sedimentary basins and pierced with a variety of igneous intrusives, began to experience lithospheric stretching mediated by mantle convection underneath. As a result, a number of rift valleys developed in its interior whilst its northeastern margins broke upin stages leaving a trail of igneous activity and lava flows. The calving continental fragments drifted northward till stalled by and joined with those lying opposite, as new ocean basins successively opened and closed behind them. The landlocked rift valleys, meanwhile, continued to fill up with sediments of the coal bearing Gondwanas. The earliest fragments drifted away from Gondwanaland around the Permian (280 Ma) and sutured with Eurasia in Jurassic(180 Ma), to form the cratonic nucleii of Iran, northern Tibet, central and northeast China, Indo-China , and eastern Thailand. A little earlier another braid of lithospheric strips had followed their erstwhile neighbours closing the sea opened up by the latter and joining up with them to create, around middle Cretaceous, thesouth and south-eastern ramparts of Asia. Finally, around early Cretaceous (130 Ma), the largest fragment constituting the

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Indian continent began to drift too, following its vast oceanic apron northward thatsubducted at trenches along southern Asia, wrapping these around itself and steadily fringing them with a volcanic arc uptil the early Eocene (~45 Ma). At this time, the Indian continent rammed into Asia greatly reducing its own speed to ~4 cm/yr as subduction of the oceanic plate transformed into continental underthrusting of the stolid Indian plate, that has continued almost unabatedly upto the present day. The extant geological structure of northeastern India, has thus been fashioned by its own persistent underthrusting of southern Tibet, and less forcibly of the Burmese block, stacking its overthrust fractured material above whilst continuing to descend in the foredeeps together with all its sedimentary coat. Slivers of the late Palaeozoic Gondwanas are indeed found plastered onto thrust sheets in the Lesser Eastern Himalaya, while Cretaceous- Palaeocene sediments of stable platform facies, acquired during its long journey from Antarctica, are exposed on the fringes of the outcropping Pre-Gondwana basement over the Shillong- Mikir Hills plateaux. Elsewhere too, they expectedly overlie this basement, now deeply flexed, and covered by later sediments , as suggested by their presence in a well drilled into the basement ridge under the Brahmaputra valley (Dasgupta et al., 2000)

26. Importance of Environmental Education as an Integral Part of Science Education: A practical approach for the North – East

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Abstract :-

The need for environmental education as an integral part of education has arisen out of a recognition of the necessity of a holistic approach to planning and development. It is an economical as well as an ethical necessity that policy makers of today and tomorrow equip themselves with the knowledge and vision to appreciate this. We would like to suggest that policy makers for science training in the North East focus on three aspects on a primary basis : resource identification , resource preservation and resource utilisation . To attain this objective , a region wise network building exercise may be undertaken.

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The network would consist , on the one hand , of vertical cooperative links between institutes of higher education and school and college going children. Centres from Universities and the I.I.T can chalk out plans to provide material and manpower resources to prepare an area wise network of the total natural environment in a scientific manner in which school and college going children may be employed in large numbers to do the field work. Horizontal links between local data bases will have to be made to create a region wise central repository of data base. The direct outcome of such a process will be the build up of a national treasure ; the indirect one is the training children will acquire in the process . It will kindle the interest of children in their natural environment. Some of them may even decide to choose as yet unconventional but nonetheless important disciplines such as ethnobotany , ornithology , geographical and geological exploration as their career goals. Resource protection is invariably linked with resource utilisation and this must be achieved with the cooperation of the local indigenous population who are a rich and living repository of knowledge on the local terrain, flora, fauna, medicinal plants , as well as rare endangered and endemic species .

We must respect the right to livelihood of those people who have traditionally depended on forest and agro based resources and ensure that they become economic beneficiaries from the commercial exploitation of these resources . Such an exercise at ground level will enable the nation to attain a leadership position in the field of research , development and sustainable commercial exploitation of natural resources. Finally , policy makers should take bold initiatives to set up pioneering R & D institutes of international standards for the sake of studying , protecting , preserving and exploiting the natural resources of the North East , which is regarded as a biodiversity hot-spot througout the world . Sadly such measures are yet to be undertaken. Central Institutes like the Central Drug Research Institute (CDRI) must come forward with their technological expertise and manpower to set up drug research institutes in the North East . The success of all these endeavours depends finally on the goodwill and enthusiasm on the part of all concerned.

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27. Landslide Hazards in North Eastern India: Perspective, Hazard quantification, and Knowledge products for design of mitigation strategies

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EXTENDED ABSTRACT:-

The North-Eastern Region of India is most picturesque area of rolling forested hills and lush green valleys, vast territory, large population and unique geo-climatic conditions. It encompasses Bhutan, China, Myanmar and Bangla Desh. It has, however, remained politically sensitive and geologically restless. Geologically, the NE Region forms a part of the Himalaya, Mishmi Mountains (part of the Shan-Malaysia Plate) and Naga-Patkai Ranges. These three terranes, having contrast physiography and distinctive geological setting, are geodynamically active. As a result, this region is prone to natural hazards, particularly the earthquakes and landslides. The NE Region falls under Zone V category, the most vulnerable seismic zone, and is considered to be the one of the six most seismically active regions of the world.

Landslide is a natural phenomenon, which is primarily because of rugged topography, unfavourable steep hill slopes, heavy & prolonged rainfall causing excessive soil erosion. It can also be defined as one of the major geological hazard that causes loss of life and property, damage to natural resources, roads, buildings, agricultural lands, disturbance to eco-system and environment. In NE Region, the hill slopes of Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Tripura, Assam experience landslides and subsidence very frequently, particularly in the monsoon. The frequency and magnitude of the landslide hazardous have been aggravated due to population explosion, unplanned urbanization, industrialization, deforestation and inadequate drainage facilities. The problem is common and much more complex with the adverse geological conditions and that the area falls under high seismicity zone. The landslide hazards have very serious impact on socio-economic structure of the region, where the impact of destruction cannot be evaluated in monetary units but rather in disruption accompanied misery to human lives.

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It is clear that the vulnerability to landslides combined with other natural hazards and socio-economic vulnerability of the people living in the North Eastern Region poses a great challenge for the government machinery. The landslide hazards, thus, need attention for comprehensive plan for disaster preparedness and mitigation. Although, a number of organizations are working for the landslide problems in the North Eastern Region, however, they work in isolation. Hence, the progress in landslide solution remains the same. It is high time that this problem be taken through an integrated multi-disciplinary and multi-institutional (users agencies, academic & R&D Institutions) approach to achieve the benefit to the maximum. It will help in understanding causes of landslides, systematic planning of developmental activities and managing landslide affected areas to maintain environmental balance.

Landslides have wide ranging impacts on the affected areas in terms of the damages cause to material and human resources and there is a need to formulate strategies for minimising the societal impact of landslides. The following factors need attention for sustainable development and to reduce geo-environmental hazards :

Landslide Inventory - Building up an inventory of landslides, i.e., history of old, active and inactive landslide, is an important area to be looked into, which may form the base information for undertaking further detailed investigations and analysis for designing optimal and effective action plans. This will help to evolve integrated mitigation measures for landslides using RS, GIS and GPS techniques.

Landslide Hazard Zonation - Preparation of Landslide Hazard Zonation maps and making them available to the concerned governmental as well as non-governmental agency, line departments, etc., for taking up necessary measures is the pre-requisite in the mitigating landslide hazards.

There is a strong need to prepare Landslide Hazards Zonation maps on 1 : 50,000 scale for regional planning; on 1:10,000 scale for district level planning; and on 1:2,000 scale for site specific microzonation. Although Landslide Hazards Zonation has been carried out by various concerned agencies on different scale in different areas, factors considered may have varied. Efforts may be made to standardize these factors to imply in all the areas.

Landslide Risk Assessment - It concerns function of hazards and loss in terms of life and properties for rational urban planning and to draw awareness amongst the people. It would

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also help in generating reliable database for better planning and to formulate various alternative plans to minimize threat to human life and property.

Monitoring and Analysis of Landslides - The magnitude of destruction depends on the location of the landslide, so recognition of precise causes of landslide is very important. Although there are various factors that cause a landslide, the particular responsible factor may be different for each individual landslide, or in other words, the various factors responsible for landslides may have different weightage in an individual landslide. Thus, an accurate diagnosis enables to understand a particular landslide phenomenon to evaluate various landslide correction techniques and to propose or adopt more effective and economic corrective measures. Thus, monitoring and analysis of the landslides becomes very important to assess current margin of safety of the slopes in strategic areas. It includes geotechnical survey to delineate engineering problems of each slide zone to prepare action plan, and networking of geotechnical instruments for regular monitoring of the landslide zones.

Human Resource Development / Public Awareness - So far the landslide hazards is taken only as academic or scientific look, but with the involvement of the masses, it has become important to educate the general public, policy makers, planners and of course the political leaders about the prevention of landslide hazards and propagate awareness of the potential benefits of landslide disaster reduction. The local community is the key element in any disaster mitigation / preparedness, which makes importance to raise the community awareness at the grassroot level. Establishment of GIS based web enabled information management system and networking of knowledge are amongst the priorities. Valdiya (2002) has suggested formulation of a public policy for hazard management and strengthening of the machinery for coping with risks of hazards through public cooperation are the imperatives of the environmental security and the planning for development. There is need to launch public awareness program and people's participation in landslide prevention and mitigation measures.

Preventive and Remedial Measures – Increasing demands to bring the isolated communities of the region into the main stream and need of the different sections of society have resulted in an increase of all types of construction activities in these areas. These activities are more alarming which are being done in unscientific manner and without following engineering norms or building codes. Thus, the consequences of the probable

landslide hazards are ignored. In order to maintain the sustainable development mitigating the losses due to landslides, there is need for developing appropriate framework for landslide hazard management. Various generalized preventive and remedial measures are suggested below :

1. Urban settlement on hill slopes should be located after evaluating the geological suitability of the site.
2. Regular monitoring of hill slopes should be carried out for slope failures. Slope modification techniques to improve slope stability may be adopted. Benching of slopes, flattening of slopes, removal of load at the slope head portion or enlarging the toe of a slope will not only reduce the slope but also trap the sliding material.
3. As most of the landslides take place in the monsoon, efforts be made for controlled flow of run-off water so as to reduce soil erosion.
4. Vegetation on barren slopes helps not only in reducing surface erosion but also increase shear strength of the slope material. Vegetation growth using jute or coir geogrids, asphalt mulch spray, etc., are beneficial to control soil erosion.
5. Dissemination of knowledge, i.e. providing education to planners and public, and training to the scientific personnel in disaster prevention, preparedness and mitigation.
6. To put display boards for the public at the areas prone for the land slides to avoid accidents

LANDSLIDE HAZARDS QUANTIFICATION IN NE REGION

Assam

Although most of the area in Assam State is plain with average elevation around 55 m, there are areas that includes hills of varied altitudes and low lying areas in form of beels, swamps, marshes, etc. The hills that form part of the Shillong Plateau and also in form of insulbergs have an altitude that vary from 170 m to nearly 300 m. Landslides in Assam are known to occur in these hill slopes. As far as 27 landslides sites are known to occur in Guwahati region – the capital city of Assam, of which 8 landslides are prominent. There are reports of various landslides in other hill parts of Assam, which is annual feature during the monsoon, where even railway traffic is affected.

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There are nearly 27 landslide sites in Guwahati region alone. These are caused due to combined effect of several factors, such as joints, rain fall, surface erosion, steep slope, prolonged weathering effect, infiltration rate, deforestation, slope disability. Although the failure mechanism varies from place to place, most of the landslides are influenced by rainfall. Large scale earth cutting on hill slopes, deforestation, unplanned construction of houses, alteration of natural drainage, etc., have destabilized the hill slopes. Prolonged weathering of the rocks is another cause, where granite, porphyritic granite gneisses, etc. have under gone various stages of weathering, which even at places are in the process of conversion into soil.

Arunachal Pradesh

Landslides are very common in Arunachal Pradesh, being the hilly State. These are caused primarily due to widening of roads, excessive rainfall, partially due to flash flood and geological factors.

In the recent past, the major landslide took place on 21st July 2002 at a number of places on the National Highway 52A between the Banderdewa-Itanagar due to heavy rainfall. This slide disrupted the road connectivity for a working day.

An interesting case of flash flood due to landslide occurred in Siang valley of Arunachal Pradesh. A major landslide in Chinese territory blocked the river flow and created heavy affluent, which subsequently burst out and caused major havoc in form of flash flood in the entire Siang Valley on 11th June 2000. It took away many lives, damaged several bridges and agricultural land. The road was also washed-off at several places.

Another devastating flash flood occurred on 4th August 2002 in hill slopes of Bomdila township of West Kameng District at an altitude of 8,000’ to 8,700’ within a radius of about 15 kms, caused due to heavy intensive rainfall A substantial damage of the public & private properties at Bomdila township and its surrounding areas was estimated approximately a few crores of rupees. It includes damage to the installations of water supply, high power transmission lines, agricultural crops, civil constructions, roads, etc. The flash flood of high momentum caused landslides in its lower course and washed-off road and two bridges. It also took 8 lives (7 Army & 1 Civil) and washed-off two army vehicles. Road communication could be restored only after 5-7 days.

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Similarly, there are number of landslides instances in **Meghalaya, Nagaland, Manipur, Tripura, Mizoram** and **Sikkim**. Details of these states are being complied.

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